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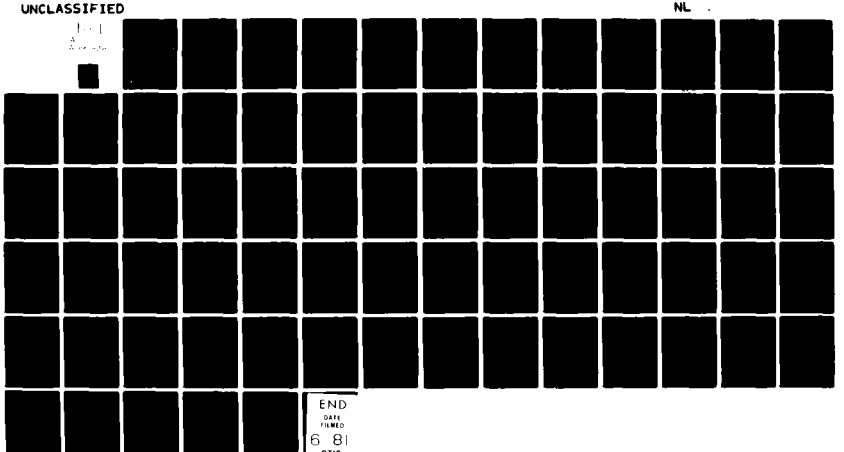

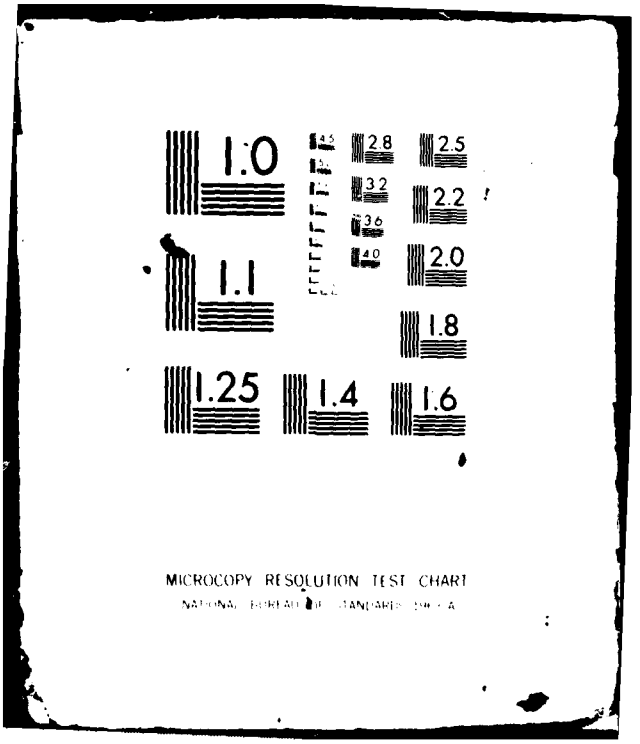
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F-16 AIRCREW TRAINING DEVELOPMENT PROJECT

Contract No. F02604-79-C8875

F-16 INSTRUCTIONAL SYSTEM DESIGN ALTERNATIVES

DEVELOPMENT REPORT No. 27

MARCH 1981

Prepared in fulfillment of CDRL no. B026

by

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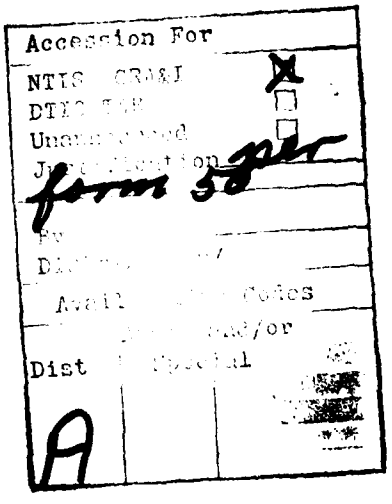
PREFACE

This report was created for the F-16 Aircrew Training Development Project contract no. F02604-79-C8875 for the Tactical Air Command to comply with the requirements of CDRL no. B026. The project entailed the design and development of an instructional system for the F-16 RTU and instructor pilots. During the course of the project, a series of development reports was issued describing processes and products. A list of those reports follows this page. The user is referred to Report No. 34, A Users Guide to the F-16 Training Development Reports, for an overview and explanation of the series, and Report No. 35, F-16 Final Report, for an overview of the Instructional System Development Project.



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EXECUTIVE SUMMARY

The purpose of this report is to present the alternative designs for the F-16 Replacement Training Unit (RTU) training system. Several designs are compared with the constraints and costs involved in their use. Though the system is capable of administering several courses of instruction at once, the costs reported are those for training B/C course students only.

While the primary purpose of a training system is to deliver instruction, there are additional functions which must be performed in order to ensure that the instructional process remains maximally effective. Many of these auxilliary functions do not need to be performed when only one set of students is to be trained; however, long term effectiveness is severly degraded if they are ignored when a system that will exist for a period of years is designed. The complete set of functions recommended for inclusion in the F-16 training system is specified in Attachment I, and is organized in terms of subsystems.

Five basic options are described in terms of their assets, limitations, and costs. These options are as follows:

Option I (Manual System) A systematically designed and updated system where the academic portion of the course is taught largely through existing instructional media (printed material, audio tapes and slides, supplemented occasionally by videotape presentations). Mediated instruction is self-paced to allow review of material or restudy of portions of lessons any time the student wishes. Use of academic instructor time to present information is minimized so that instructors can maximize the time spent dealing with individual problems and questions. Use of training devices and aircraft is carefully integrated with self-paced and classroom instruction so that the student can derive maximum benefit from equipment use through complete and thorough preparation. Centralized record keeping and administrative functions, as well as distributed scheduling functions, are carried out using form driven procedures such that lesson updates, data base changes, etc., are handled as efficiently as is possible without automated data processing support.

Option II (Basic CMI-augmented System) This option adds automated data processing support for centralized administrative and distributed scheduling functions. By keeping track of individual student progress as well as student response to individual lessons on line, individualized syllabus options are more readily generated and specific instructional deficiencies are more readily identified and corrected. In this way, the mediated, self-paced instruc-

tional plan detailed in Option I is more fully utilized while support personnel spend less time performing clerical duties and have more time to plan for systematic improvements.

Option III (Basic CMI, CAI, and part-task Training System). This option adds the capability of computer-assisted instruction (CAI) and computer controlled part-task hands-on training to the computer management package whose impact is described in Option II. These new capabilities allow learner control at the learning strategy level so that in addition to individual syllabus prescription, students also benefit from the ability to select the method of studying each lesson that best suits their individual cognitive style. Since CAI-mediated lessons allow the unique self-tailoring of instructional presentation by many students simultaneously, individual differences in learning style are better accommodated. In addition to a greater degree of individualization in academic instruction, the addition of computer controlled part-task hands-on training allows the system to provide more and better training in basic psychomotor tasks, providing greater amounts of monitored hands-on instruction while increasing instructor availability for supervising higher order hands-on training in more complex training devices.

Option IV (Full CMI, CAI, and Integrated part-task Training System with Automated Performance Resource Capability). Under this option, the capabilities described in Option III are expanded to increase the amount of instruction that can be placed under learner control with the addition of an automated performance measurement system. Such a system allows the measurement and recording of student performance at any point in his individual program of instruction. This in turn allows more accurate diagnoses of individual problem areas and instructional deficiencies. Such a performance measurement system need not be restricted to academic instruction only, but can also encompass the measurement and recording of student performance on computer controlled hands-on training.

Option V (Addition of Automated Performance Measurement). This option expands the performance measurement system to incorporate automated performance measurement of in-flight tasks through the use of Air Combat Maneuvering Instrumentation. This allows precise, objective measurement of in-flight performance, as well as student self-evaluation by means of the recording and playback features of the system. By adding this capability, the precision of diagnosis of individual problems in actual job performance is greatly enhanced, allowing for maximally useful remediation.

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SYSTEM DESIGN ALTERNATIVES

1.0 PURPOSE

The purpose of this report is to present the alternative designs for the F-16 Replacement Training Unit (RTU) training system. Several designs are compared with the constraints and costs involved in their use. Though the system is capable of administering several courses of instruction at once, the costs reported are those for training B/C course students only.

2.0 CREATION OF ALTERNATIVES

While the primary purpose of training system is to delivery instruction, there are additional functions which must be performed in order to ensure that the instructional process remains maximally effective. Many of these auxilliary functions do not need to be performed when only one set of students is to be trained; however, long term effectiveness is severly degraded if they are ignored when a system that will exist for a period of years is designed. The complete set of functions recommended for inclusion in the F-16 training system is specified in Attachment I, and is organized in terms of subsystems.

While all the functions listed in Attachment I could be performed at each training site, it may prove more efficient to centralize much of the record keeping and administration to ensure that training is standardized across training sites. This centralization is particularly beneficial in ensuring that modification to academic instruction are distributed to all sites. Figure 1 represents the assumed command structure within which the F-16 instructional system must function. A recommended allocation of functions to these command levels is presented below.

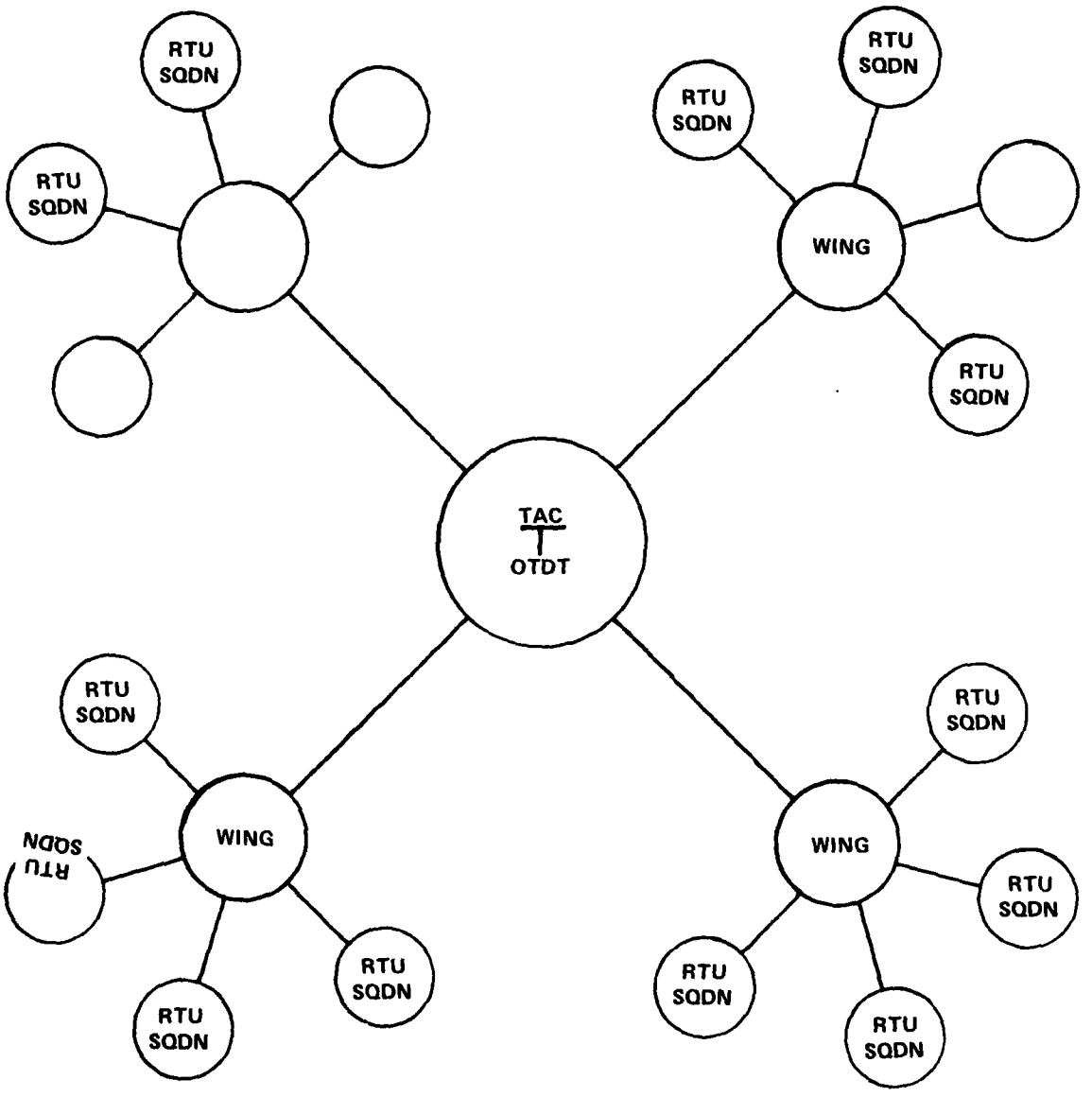

FIGURE 1. CONCEPT OF F-16 TRAINING SYSTEM ORGANIZATION AND FUNCTION ALLOCATION.

TAC FUNCTIONS

1. Provide general system administration.
2. Supervis instructiona materials maintenance.
3. Perform data base maintenance.
5. Perform system procedures maintenance.
6. Monitor/Coordinate formative evaluation.
7. Perform graduate evaluation.
8. Implement system change.

WING FUNCTIONS

1. Perform local instructiona administration.
2. Screen and administer incoming students.
3. Prescribe incoming remediation.
4. Provide remediation.
5. Train system personnel.
6. Supervise formative evaluation.
7. Maintain facilities and equipment.
8. Perform formative evaluation.

RTU SQUADRON FUNCTIONS

1. Provide and supervise instruction.
2. Conduct performance measurement.
3. Provide student advisement.
4. Maintain local materials inventories.
5. Monitor personnel.
6. Maintain facilities and equipment.
7. Participate in formative evaluation.

The design alternatives listed in this report are generated by varying the manner in which the subsystems listed above and in Attachment I are implemented and/or administered. This allows the specification of a system that is immediately attainable as well as a series of growth steps to imporve future capability and capacity, at the same time ensuring that all required auxiliary functions are addressed in all configurations.

The total number of configurations possible is quite large. For convenience in considering alternatives, the number of options has been reduced to five, the number which represents the most important variations subsystem implementation which will have either cost or benefit impact.

The options are:

Option I--A systematically designed and updated system where the academic portion of the course is taught largely through existing instructional media (printed material, audio tapes and slides, supplemented occasionally by videotape presentations). Mediated instruction is self-paced to allow review of material or restudy of portions of lessons at any time the student wishes. Use of academic instructor time to present information is minimized so that instructors can maximize the time spent dealing with individual problems and questions. Use of training devices and aircraft is carefully integrated with self-paced and classroom instruction so that the student can derive maximum benefit from equipment use through complete and thorough preparation. Centralized record keeping and administrative functions, as well as distributed scheduling functions, are carried out using form driven procedures such that lesson updates data base changes, etc., are handled as efficiently as is possible without automated data processing support.

Option II--This option adds automated data processing support for centralized administrative and distributed scheduling functions. By keeping track of individual student progress as well as student response to individual lessons on line, individulized syllabus options are more readily generated and specific instructional deficiencies are more readily indentified and corrected. In this way, the mediated, self-paced instructional plan detailed in Option I is more fully utilized while support personnel spend less time performing clerical duties and have more time to plan for systematic improvements.

Option III--This option adds the capability of computer-assested instruction (CAI) and computer controlled part-task hands-on training to the computer management package whose impact is described in Option II. These new capabilities allow learner control at the learning strategy level so that in addition to individual syllabus prescription, students also benefit from the ability to select the method of study-

ing each lesson that best suits their individual cognitive style. Since CAI-mediated lessons allow the unique self-tailoring of instructional presentation by many students simultaneously, individual differences in learning style are better accommodated. In addition to a greater degree of individualization in academic instruction, the addition of computer controlled part-tasks hands-on training allows the system to provide more and better training in basic psychomotor tasks, providing greater amounts of monitored hands-on instruction while increasing instructor availability for supervising higher order hands-on training in more complex training devices.

Option IV--Under this option, the capabilities described in Option III are expanded to increase the amount of instruction that can be placed under learner control with the addition of an automated performance measurement system. Such a system allows the measurement and recording of student performance at any point in his individual program of instruction. This in turn allows more accurate diagnoses of individual problem areas and instructional deficiencies. Such a performance measurement system need not be restricted to academic instruction only, but can also encompass the measurement and recording of student performance on computer controlled hands-on training.

Option V--This option expands the performance measurement system to incorporate automated performance measurement of in-flight tasks through the use of Air Combat Maneuvering Instrumentation. This allows precise, objective measurement of in-flight performance, as well as student self-evaluation by means of the recording and playback features of the system. By adding this capability, the precision of diagnosis of individual problems in actual job performance is greatly enhanced, allowing for maximally useful remediation.

Statement of work CDRL B026 calls for system design alternatives to address: (1) a system designed with all current constraints operating upon the design, (2) a system designed observing media constraints only, (3) a system designed with constraints chosen by the contractor. Alternative number 1 above is represented by Option I, which recognizes current restrants on training resources and funding by handling scheduling, record keeping, testing and instruction with form driven processes, currently available instructional media and hands-on training devices. Alternative number 2 above is represented by by Option II and by that portion of Option IV which involved CMI. Since costs for CAI and CMI are reported separately in this report, the relevant costs for a CMI-only system are easy to obtain. Alternative number 3 above is represented by Options III, IV, and V. These Options have been chosen to form a pattern of successive training system configurations in which constraints on funding and training devices procurement are successively removed.

3.0 REPORTING OF COSTS

Statement of work CDRL B026 asks the contractor to provide design plan for "an optimum cost effective training sytem" and to provide "cost estimates for the design (here the meaning interpreted is "implementation and operation") of each course/training system." Given the present state of the art in instructional technology and cost effectiveness measurement techniques it is not possible to quantify the benefits of a training program sufficiently to select an "optimum" system configuration through cost benefit methods. While savings in dollars are reported where possible, benefits such as increased rate of acquisition of information and increased retention and transfer due to increased media flexibility and the degree to which this allows an increase in learner control are presently sufficiently beyond the state of the art to be reported in terms of reliable dollar and time estimates.

When the features of each option are compared, however, it is readily apparent that new capabilities are introduced in successive options that can be expected to yield increases in training effectiveness of the above-described sorts. Because of these increases in capability which accompany cost increases, direct comparison of costs is not an appropriate method of choosing the best design alternative.

As each new option is introduced in this report, the new costs associated with it are detailed, along with the areas in which savings over previous option costs may be obtained. All cost figures are the best estimates which could be made at present and are reported in today's prices and today's dollars. No adjustments are made for inflation or for the trend in prices. However projections indicate that the cost of personnel will rise, while the cost of computing machinery will fall.

In comparing costs, readers should be aware that programming costs for all computerized systems are necessary for the first copy of the system only and may be subtracted from the cost of subsequent systems. Moreover, cost reductions often attend the procurement of multiple systems, but those are not projected in this report.

Finally, in comparing costs, it should be kept in mind that one system may usually be made to serve more than one community. Experience in previous training systems has shown that multiple users of a system, once it is established, may reduce the per student cost of use to very low levels. Those possibilities are not accounted for in the fiugres reported here, but should be considered where they are determined to be viable.

4.0 PRESENTATION OF THE ALTERNATIVES

Each of the five system options is presented in this section with an overall summary of system features, a list of expected benefits, and estimated added or subtracted costs.

4.1 Option I--Manual System

Summary: This is a manual (noncomputerized) configuration of the system which is is nonautomated and based upon present constraints of time, equipment, personnel, and funding. These contraints are reported in project report no. 15, "Program/System Constraints Analysis Report."

This version of the system represents a departure in several beneficial ways from traditional RTU training practices. Major differences include:

1. A set of explicit management procedures to enable system managers to receive timely reports on system activity, effectiveness, and resource consumption and use those data in the systematic update and self-maintenance of the system.

2. A regular data collection schedule to gather information on system performance for the management reports described above.

3. More heavy reliance upon mediated instructional presentations, which will increase presentation consistency and lessen pressures caused by instructor shortages, freeing instructors for more appropriate duties.

4. A self-paced instructional environment in which students move at the rate best suited to their study habits and rate of learning of the content while still meeting with major course milestones on schedule.

5. Increased emphasis on problem-solving by groups of students working on real-world-like tactical planning problems.

6. Performance measurement against criteria standardized between instructors.

7. Easy-to-use gradeslips designed to facilitate end-of-flight debriefs by instructors and containing diagnostic information of use to future instructors concerning student errors and tendencies.

8. A procedure for maintaining critically important data base documents such as task listings and objectives continually in current form.

9. A more detailed syllabus building procedure resulting in better ability to track and describe student progress and better control syllabus contents and syllabus economy.

Training devices for this configuration of the system will consist only of those presently approved and procured, including:

1. Stick and throttle trainer
2. Stores management set (SMS) desktop trainer
3. Avionics mockup
4. Detachable panels and cockpit mockup
5. CFT
6. EPT
7. OFT
8. DSS--for temporary use only
9. ASPT--for temporary use only
10. Actual equipment

Media for academic instruction will consist of workbook, workbook accompanied by slides, slides accompanied by audiotape and worksheet, and videotape. Printed instructional materials will be issued to the student, and a Learning Center will provide viewing devices and study areas.

The function of the instructor under this and all other configurations of the system varies substantially but importantly from the traditional role of the instructor. The traditional instructor role allocates a major portion of the instructor's time and attention to the delivery of information to the student. Through the use of mediated instruction the F-16 system will be able to bring consistency to basic instruction in many areas of content and remove from instructors the load of repetitive presentations of factual and procedural instruction. The shift in instructor behavior from a deliverer of information is important to the proper operation of the F-16 system. The training given instructors will emphasize this perspective and give instructors the skills they will need.

The prime limitation of this configuration of the F-16 training system will be its nonautomated status. The volume of data gathering, manipulation, and reporting required to operate an instructional system is extensive. Records must be kept up to date, students must be progressed through a complex sequence of instructional events in a variety of optional paths, the syllabus must be kept current, instructor certifications must be kept current, equipment and facilities must be scheduled, progress reports must be written, and the instructional materials must be maintained and inventoried. All of these are nontrivial tasks more extensive in many areas than those which at present normally occupy the time of a large training squadron staff.

The Option I version of the system will be capable of carrying out the normal training functions along with many new ones. The system functions listed in Attachment I will be

implemented up to the extent possible given manpower and time constraints. Most important functions will be implemented first, and subsequent functions will be implemented as possible in a priority order. Some functions may be implemented at a less than optimal, yet useful level of completeness.

Benefits: The benefits expected to accrue to TAC (Tactical Air Command) under this system include:

1. An anticipated reduction in instructor requirement due to mediation of much of the instruction normally administered over the podium. This will allow reassignment of instructors to more appropriate duties.

2. An anticipated increase in student ability to perform in aircraft and training device sessions due to better instructional preparation, device session supporting materials, and device session arrangement.

3. An anticipated increase in management responsivieness to training problems and training system maintenance tasks due to a better data gathering and reporting system (to the level of manpower availability).

4. An anticipated increase in student ability to handle real-world tactical planning problems because of increased exposure to such problems during training.

5. An improved knowledge of exact student performance capabilities and problems during training and upon graduation due to improved diagnostic gradeslips.

6. An improved ablity by receiving operational commanders to interface continuation training activities with student exit level from RTU due to more detailed and syllabus-based record keeping.

It will be necessary for a decision to take place at the time of system implementation concerning the exact management procedures which can be fully implemented and to what extent. Special care must be exercised to identify that minimum of activity which will allow the system to run effectively.

Personnel and resource requirements and costs: Personnel and resource requirements and costs for the Option I system configuration are reported in Table 1. Computation of resource requirements was carried out using the "F-16 Instructional System Cost Study Report," project report no. 21. All resource computations for this and subsequent options are based on the present version of the syllabus for F-16 B/C course training and the present student load projections as obtained from HQ/TAC via the F-16 Operations Training Development team (OLAG, 4444th Operational Squadron, Luke AFB, Arizona).

Table 1

COST OF TRAINING SYSTEM OPERATION
FOR OPTION I SYSTEM CONFIGURATION*

Capital Costs

Learning Center media procurement and operations	$ 9,500
Classroom equipment procurement and operation	1,000
Office furnishing procurement	40,500
TOTAL	$50,100

NOTE: The costs of the already-procured training devices and training device facility at Hill AFB need to be added to this figure for a complete estimate of capital costs. These figures were unavailable to the contractor.

Operating costs

Instructor salary (unburdened)	$ 1,096,901
Learning Center personnel	13,536
Support personnel	120,024
Instructional development personnel	73,920
TD equipment operators	20,000
TD equipment maintainers	247,500
Aircraft operation	28,588,800
Learning Center media equipment maintenance	1,000
Office space maintenance	226,800
Learning Center and classroom maintenance	91,000
Ammunition costs	1,741,440
Media production services	5,000
TOTAL	$31,779,231

NOTE: Training device maintenance costs need to be added to this figure, when they are know, for a complete estimate of total operating costs.

* Figures are based upon training 160 students per year at Hill AFB, Utah, and are taken in part from the Appendix of project report no. 21, "F-16 Instructional System Cost Study Report." Note that all personnel costs are unburdened. To obtain a burdened rate, personnel costs must be multiplied by a factor of approximately 1.3. Calculations assume OFT availability at beginning of training.

4.2 Option II--Basic CMI-Augmented System

Summary: This configuration of the F-16 training system includes the computer automation of certain key reporting and scheduling functions. All of the constraints presently applying to F-16 training would apply under this system as well, with the exception of funds for the design, procurement, installation, and operation of the computerized management component. In this configuration the system would be involved in a basic way with what is commonly called computer-managed instruction (CMI).

As a minimum the following scheduling functions should be automated under this configuration of the training system:

1. Daily scheduling of Learning Center activities for students.
2. Academic test scheduling and grading.
3. Training equipment needs, given student progress (though no scheduling of specific end items to students).
4. Instructor schedules.
5. Performance measurement test scheduling.
6. Student entry level determination and make-up instructional prescription.
7. Student scheduling.
8. Materials revision production scheduling.
9. Fault identification and formative evaluation scheduling.
10. Data base maintenance scheduling.
11. Personnel training and recertification scheduling.
12. Graduate evaluation organization and scheduling.
13. Change implementation scheduling.

Also, the following recording and reporting functions would be automated:

1. Learning Center materials and equipment use reports.
2. Instructional progress reports.
3. Testing results reports.
4. Instructor activity reports.

5. Training equipment use reports.

6. Incoming student report and record setup.

7. Outgoing student reports and notifications.

8. Materials revision production progress reports.

9. Personnel utilization reports.

10. Materials and equipment inventory reports.

11. Data base printout updates.

12. Personnel training and recertification reports.

13. Formative evaluation reports.

14. Graduate evaluation reports.

15. Graduating student summary reports.

Benefits: The same general functions would be performed within this system as under Option I. The addition of computer support for certain basic system management functions, however, would allow some functions performed under the Option I system to be performed in a way that would produce more detailed and timely reporting of system activity and effectiveness. Computerization would also allow reduction of administrative support personnel. Automation would also allow more timely and efficient scheduling in those areas which would be automated. In many cases this would mean that management procedures which were being carried out at the marginally adequate level dictated by the Option I manpower constraints, could be improved even with lower manpower utilization, and that the management decision-making process could be based on more complete data. In addition, the increased timeliness and thoroughness of computerized schedules would allow more complete utilization of existing resources.

The importance of good and timely management of the broad range of F-16 system functions must be emphasized. Failure of many instructional development programs in the past has been due not to inadequate training systems but to failure to properly administer the systems once they were designed and built. Common to many instances is the problem that increased sophistication of the training system, its materials, and its methods requires also increased sophistication of the management applied to the running and maintaining of the system. Analogous problems are found where inadequate emphasis and planning is committed to the operation of any weapons system. Though the resources allocated to the management of the Option I system are adequate, they are minimal and force the curtailment of many activities and an increase in administrative manpower.

Under this version of the system there would be no change in the instructional media assignments from the Option I system, therefore there would be no new instructional development cost incurred. Neither would there be a change in the training devices used within the system. This avoids new device procurement costs.

Personnel and resource requirements and costs: Added costs for the Option II system configuration are reported below in Table 2. Cost reductions are reported in Table 3. Details for Table 2 and 3 backup are found in Attachment II.

Costing for the Option II system was based upon the computer hardware system portrayed in Figure 2. This and all subsequent systems were designed to incorporate the management criteria features enumerated in project report no. 12, "Management System Needs and Design Concept Analysis," and project report no. 17, "Computer-managed Instruction for the F-16 Training Program." Built into this system are the redundancies to provide back-up in case of breakdowns and to accommodate either surges or steady growth in demand level.

Table 2

ADDED COSTS FOR OPTION II
OVER AND ABOVE OPTION I COSTS

One-time costs	
Equipment	$169,500
Installation	26,000
Programming	96,000
TOTAL	$291,500
Annual costs	
Material & supplies	$ 4,000
Maintenance	17,000
Personnel	54,000
TOTAL	$75,000

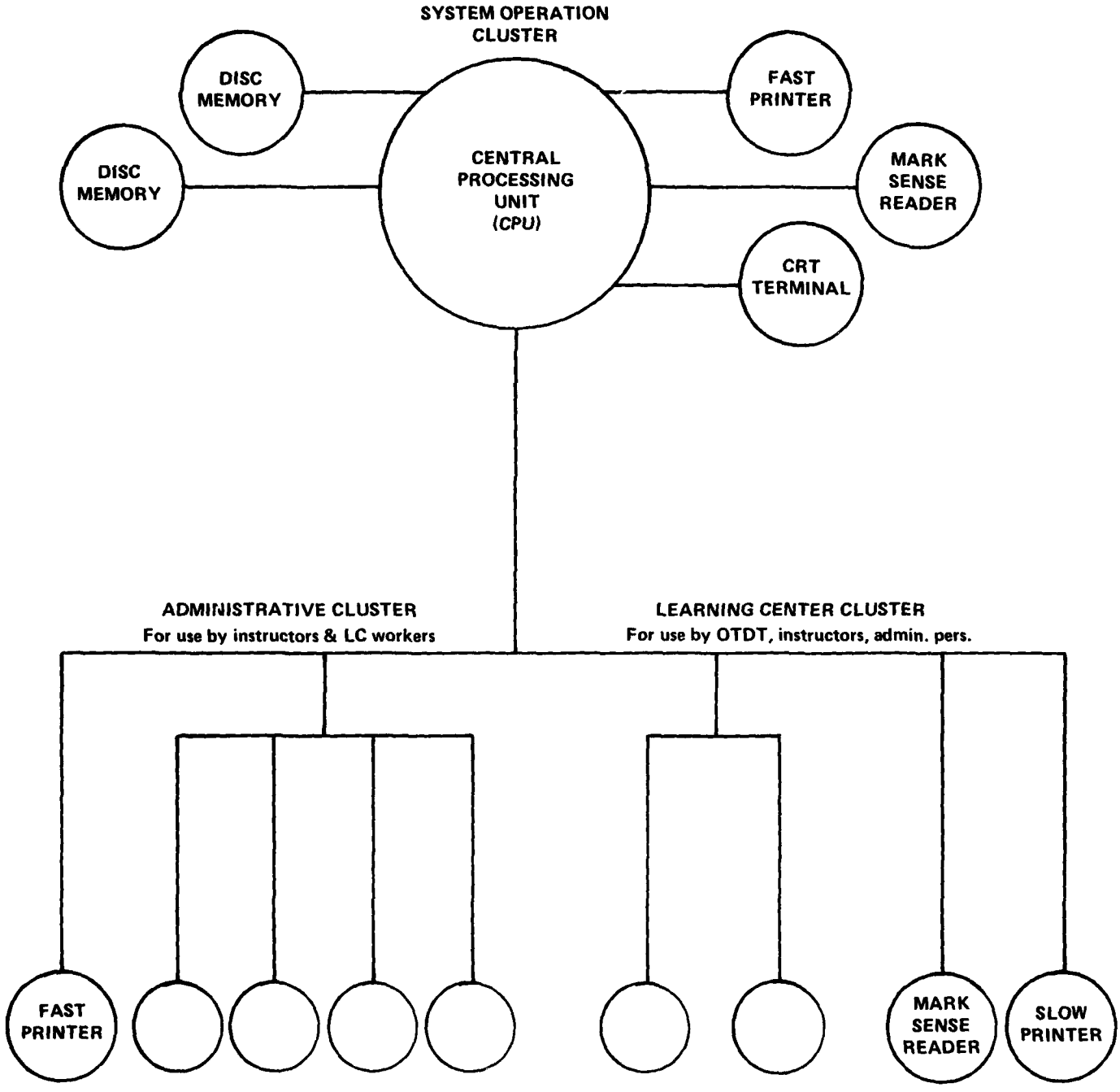

FIGURE 2. CONFIGURATION ASSUMED FOR THE OPTION II CMI SYSTEM

Table 3

REDUCTION IN COSTS FOR
OPTION II OVER OPTION I COSTS

Item	Amount
Reduction in annual cost for four administrative personnel and their related costs	$40,272
TOTAL	$40,272

4.3 Option III--Basic CMI, CAI, and Part-Task Training System

Summary: This configuration of the F-16 trianing system includes retention of the CMI capability described for Option II and in addition the computerization of some academic instruction would include the more complex area of tactics instruction (making it compter-assisted instruction, or CAI) and the further use of the same computer system to provide interactive part-task trainer capabilities for the more complex F-16 avionics and weapons systems.

Benefits: The computer as an instructional device combined with sophisticated instructional strategies is uniquely suited to instruction in complex topics which require fine discriminations and problem solving to be learned. It possesses enhanced still, motion, and color display capabilities and the ability to respond instantaneously to student input. These important features become especially useful in representing a variety of complex tactical problems, allowing the student to interact with the computer in their solution, and giving the student immediate feedback on the outcome of the decision. The ability to create instructional experiences of this type would have a further regularizing effect on the content given each student. It would not only release much instructor time for other instructional functions, but would improve the overall quality of basic tactics instruction by allowing the student to participate interactively in the solution of a broad range of tactical problems.

In addition to these instructional benefits, a second class of benefits would become available under this option related to training device and simulation capabilities. Resident within the same computer system a variety of simulated part-task trainers would be built which would fill a need existing in the present training device array. A part-task trainer can be useful in bringing to criterion performance those skills involved in the operation of a complex aircraft subsystem. The F-16 has some subsystems of sufficient complexity to require such trainers, such as the Stores Management Set and the Fire Control/Navigation

panel, and adequately designed trainers in these subsystems are not now contemplated.

Prior to entering more complex training devices such as the Operational Flight Trainer (OFT) or the aircraft, if students have had sufficient practice in the operation of the subsystems to be able to use them competently in the course of a training problem, a benefit is realized and training device time has been economized and the full systems trainer time may be used for training problems which require all systems to be operated. If, on the other hand, skills in operating complex subsystems have not been developed to a sufficient level, time in full system simulators can be wasted while the student attempts to learn how to use the subsystem. Full system simulation problems which encounter this type of student problem are not being used to the level of efficiency they could be, yet it is not uncommon to find this inefficiency occurring in most air training communities. Since there are implications for aircraft operating time and expense in misuse of training device capability, use of the part-task trainers should be expected to produce aircraft flight time economies. Three percent is estimated.

The range of training devices available under earlier configurations of the system would be supplemented by the addition of these part-task trainers. In some cases, less capable trainers already procured would be replaced and made available for longer periods of time to a larger number of students, handling a broader range of problem situations. The real benefit inherent in this plan is that a minimum cost would be incurred, since only modifications to existing CFT equipment and the CAI system would have to be made to realize the part-task training capability. No new equipment procurements would be required over the CAI system execpt for additional CFTs, and interfacing and programming of already existing equipment is all that would be required. In one possible scenario, use of a two dimensional simulator, even CFTs would not need to be procured over those already owned by the USAF.

Personnel and resource requirements and costs: Added costs for the Option III system configuration are reported below in Table 3 along with cost reductions.

Costing of the CAI component is addressed in two ways for the purposes of contrast. The first way assumes that a CAI system will be built from the ground up, including all software development necessary to provide a flexible authoring language for materials development. The second way to costing assumes an already developed CAI system can be procured with an existing CAI authoring language available. Both systems would be configured as in Figure 3. Additionally, part-task training costs are reported for two attainable alternate configurations: (1) a three-dimensional system utlizing CFTs as input and display points for student interaction and (2) a CRT-based two-dimensional system in which the student would interact through

displays and inputs to the CRT with no decrement in training capability.

Added costs for both versions of the CAI component are reported in Table 4. Added costs for both versions of the part-task training component are reported in Table 5. Cost reductions attendant to system use are found in Table 6.

Table 4

ADDED COSTS FOR OPTION III DUE TO CAI INCLUSION UNDER TWO VERSIONS

Version I: CAI procured as a service-built system from the ground-up, including programming of the authoring system.

Costs	Ground-up System
One-time Costs	
Equipment	$ 280,500
Installation	14,000
Programming	1,596,000
Interface	10,000
Instructional development	95,130
TOTAL	$1,999,630
Annual Costs	
Material & Supplies	$ 4,000
Maintenance	28,000
Personnel	54,000
TOTAL	$86,000

Version II: CAI procured as an existing system, including an existing authoring system.

One-time Costs

Equipment	$230,000
Installation	14,000
Programming	
Interface	110,000
Instructional development	95,130
TOTAL	$449,130

Annual Costs

Material & supplies	$ 4,000
Maintenance	28,000
Personnel	54,000
TOTAL	$86,000

Table 5

ADDED COSTS FOR OPTION III DUE TO PART-TASK TRAINING FUNCTIONS UNDER TWO VERSIONS

Version I: Part-task training utilizing three-dimensional (CFT-based) displays and controls.

One-time Costs

Equipment	$100,000
Installation	10,000
Programming	100,000
Instructional development	8,740
TOTAL	$218,740

Version II: Part-task training utilizing two-dimensional (CRT-based) displays and controls.

One-time Cost

Equipment	$10,000
Installation	10,000
Programming	50,000
Instructional development	8,740
TOTAL	$78,740

Table 6

REDUCTION IN COSTS FOR OPTION III OVER OPTION II COSTS

Item	Amount
Reduction in annual aircraft operating expense	$ 857,664
Reduction in annual instructor salary expense (incuding facilities reduction)	$ 151,428
TOTAL	$1,009,092

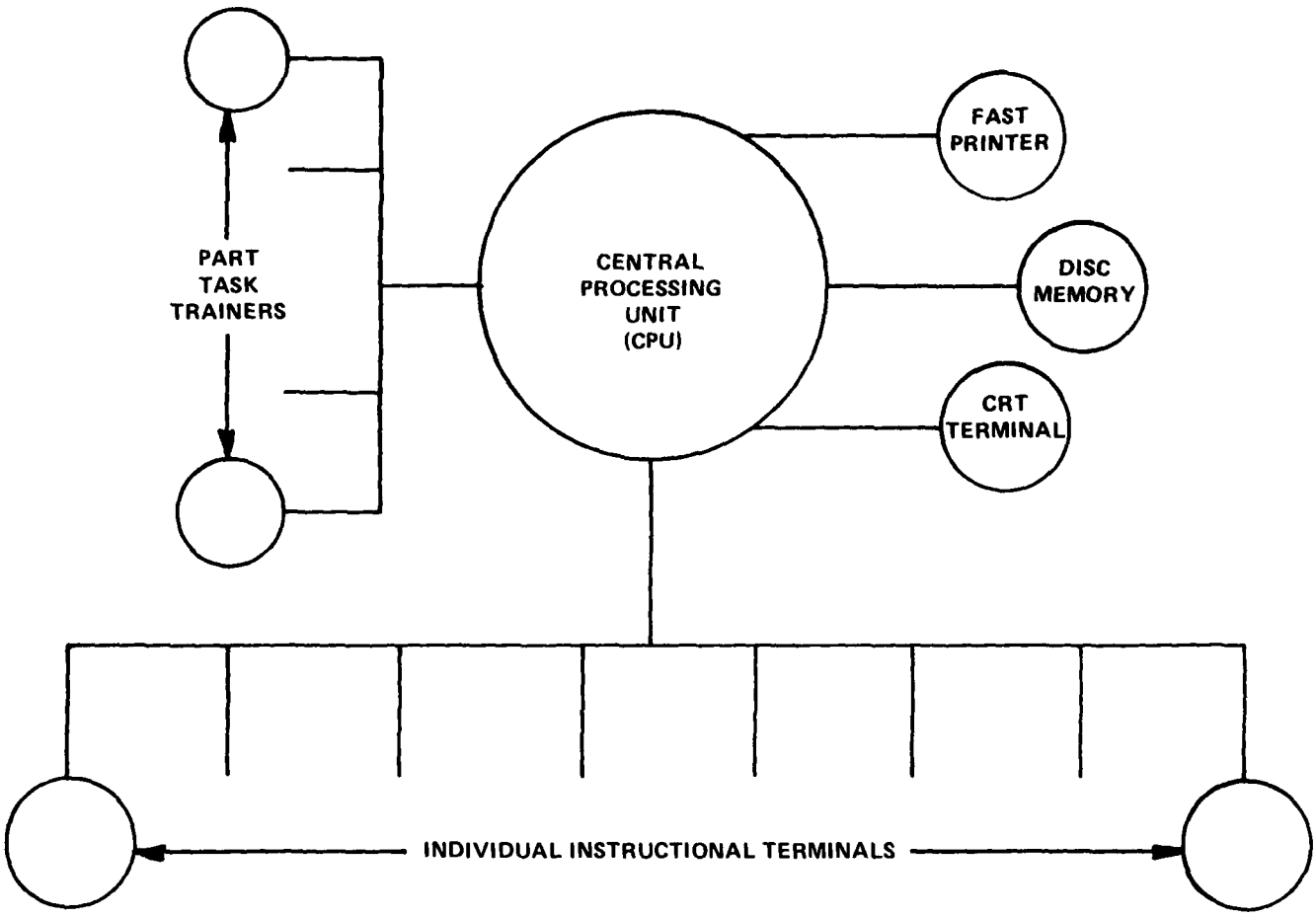

FIGURE 3. CONFIGURATION ASSUMED FOR THE OPTION III CAI SYSTEM.

4.4 Option IV--Full CMI, CAI, and Integrated Part-Task Training System with Automated Performance Records Capability

Summary: This configuration of the F-16 training system includes the capabilities of all previous system options expanded to include a full CMI system, fully inclusive CAI system, integration of the part-task trainers and extension of their capabilities, and automation of flight debrief and gradeslip completion. The recommended full CMI system would include automation of all record keeping and reporting functions and the creation of a state-of-the-art scheduling system.

Recording and reporting functions which would be newly automated include all of the remainder of the system recording and reporting functions described in Attachment I not automated in the basic CMI system.

Automation of scheduling is expanded under this option to include not only the scheduling of daily events at each training site, as detailed under Option II, but also the generation of macro-schedules which take into account resources and constraints over large geographic areas and time periods. Automating the centralized long term scheduling functions allows the rapid examination through trail projection of any system-wide impact resulting from events such as the introduction of a lightly advanced simulator that is available at only one location, or a new site selection for a single RTU squadron. While this level of projection may not be immediately possible, it is expected that a basic centralized scheduling system could be implemented which would provide for resource scheduling of personnel, trainers, aircraft, and maintenance activities system-wide with a lower than 5 percent manual reconcile rate and 1-2 week projection capability.

The CAI system would expand to include all instruction and extensions to air and ground combat computer simulations as problem-solving vehicles for students. Part-task trainers would be integrated in a way that would allow interactive simulation of several systems at once, whereas previous options would include only isolated system simulations.

The automation of debrief and gradeslip completion would entail an on-line terminal based activity completed by the instructor and the student in real-time. Fully automated performance measurement is not recommended at present due to the limited state-of-the-art in that area, but extensive interface and cooperation between the F-16 system and performance measurement researchers is recommended to advance the capabilities in that area to a level of day-to-day utility.

Benefits: Under the fully automated record keeping and reporting system it is projected that a level of detail and amounts of data mainipulation will be possible which will enhance system managers' ability to detect problems, prescribe solutions,

and monitor results. Administrative and clerical manpower required for recording and reporting will be reduced by an estimated additional 25 percent.

Computer-assisted instruction under this option will automate not only all preexisting instruction and media presentations by absorbing them into the CAI system, but will also add capabilities in the area of simulation of air and ground combat problems for student interaction. The possiblities in this area are quite broad and include simulation of planning problems and of real-time employment of plans in combat scenarios. It will be possible with this type of system to give the student much realistic combat situation experience without incurring aircraft or simulator expenses.

Part-task trainer integration would allow interactive instruction and practice on several of the F-16's complex avionics systems at once, including simulation of emergency or degraded operation modes. It would also allow practice on more sophisticated avionics tasks to be moved from the OFT to a lower level trainer, making OFT time available for other training tasks or heavier student volumes. This will impact aircraft use time favorably.

Automation of debrief and gradeslip completion would reduce paperwork and clerical loads in a heavy volume area while at the same time (a) increasing the flexibility of gradeslip contents and format, (b) increasing the amount of student progress data available to instructors in reports prior to subsequent flights, and (c) shortening and increasing the value of the debrief to the student and instructor both through the removal of administrative work from the instructor and the gruarantee of a more complete and focused debrief for the student, without increasing debrief time.

Personnel and resources requirements and costs: Added costs for the Option IV system configuration are reported in Table 7. Costs are based on the equipment configuration presented in Figures 4A and 4B. Cost reductions under this system are reported in Table 8.

Table 7

ADDED COSTS FOR OPTION IV OVER
OPTION III COSTS

One-time Costs	
Equipment	$115,000
Installation	14,000
CMI software1	96,000
PTT software	100,000
Instructional development	241,313
TOTAL	$566,313
Annual Costs	
Materials & supplies	$ 4,000
Maintenance	17,000
Personnel	-0-
TOTAL	$21,000

Table 8

REDUCTION IN COSTS FOR OPTION IV OVER
OPTION III COSTS

Item	Amount
Additional reduction in annual aircraft operating expense	$554,622
Reduction in annual instructor salary expense	75,780
Reduction in annual cost for three administrative personnel and their related costs	30,204
TOTAL	$660,606

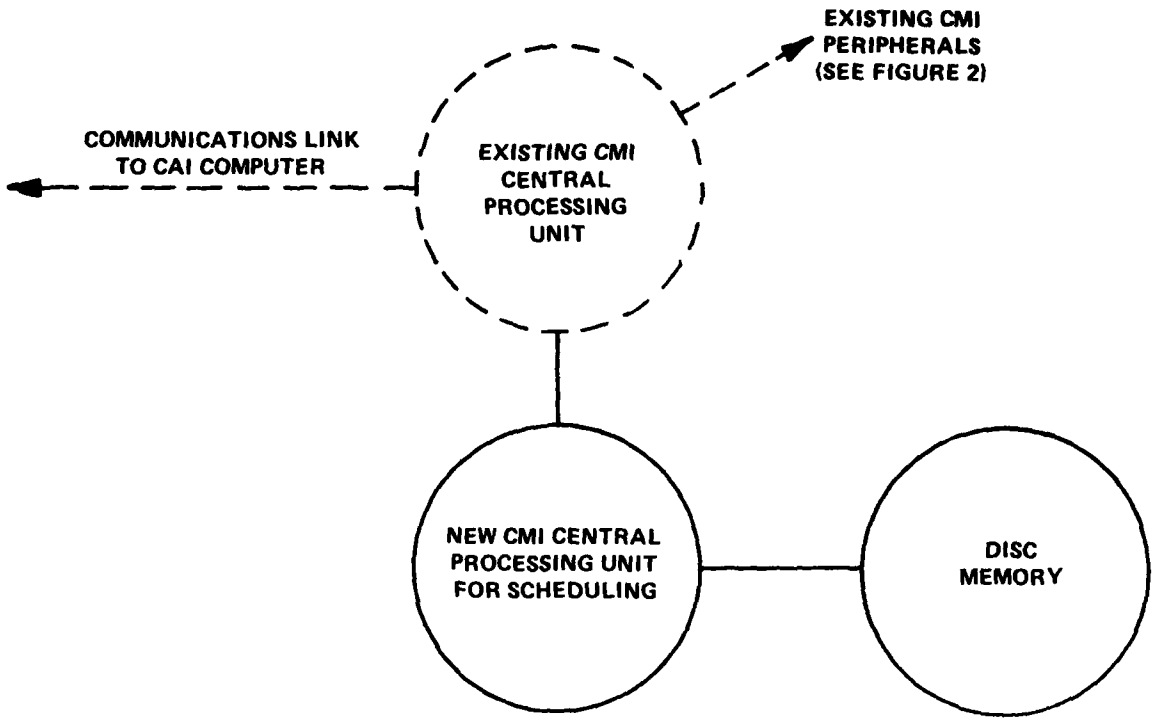

FIGURE 4A. EQUIPMENT ADDITIONS TO THE CMI SYSTEM FOR OPTION IV
(NEW EQUIPMENT IN SOLID LINE)

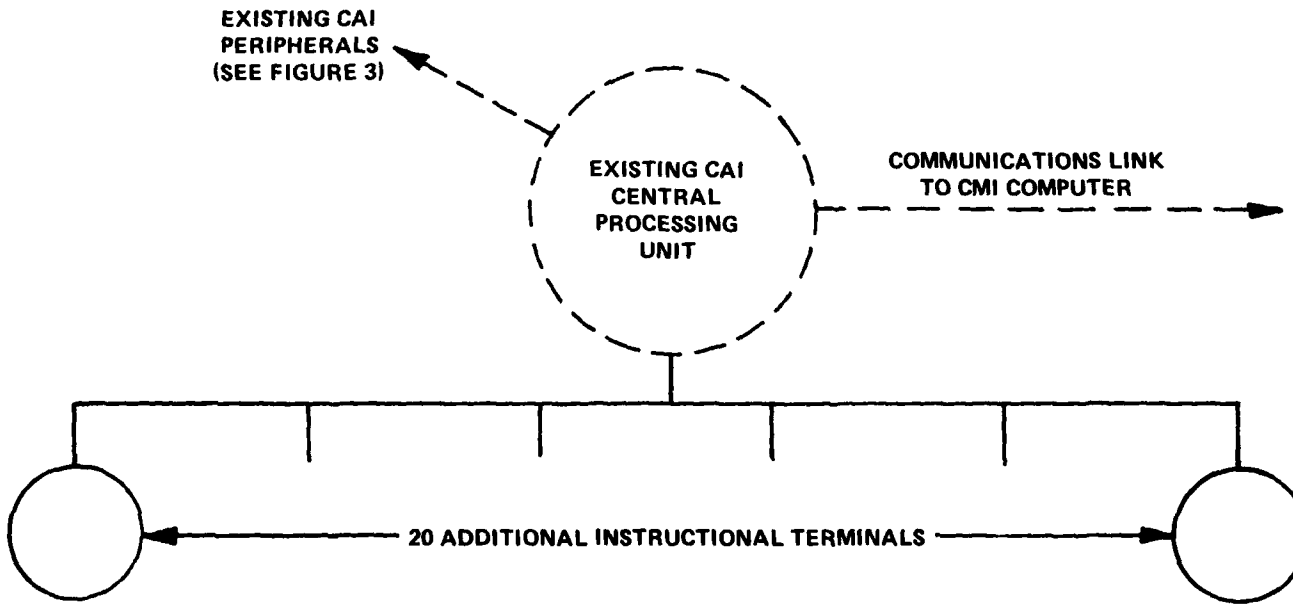

FIGURE 4B. EQUIPMENT ADDITIONS TO THE CAI SYSTEM FOR OPTION IV
(NEW EQUIPMENT IN SOLID LINE)

4.5 Option V--Addition of Automated Performance Measurement

Summary: This option consists of adding to the Option IV system additional performance measurement capability in the form of an Air Combat Maneuvering Instrumentation (ACMI) system or its equivalent. This system is capable of recording and visually recreating details of an air or ground combat engagement for a large number of combatants.

Benefits: The ability to replay engagements in detail has taken much of the guesswork and reliance on memory reconstructions out of the area of fighter combat evaluations. It is difficult to estimate the amount of improvement in measurement capability and benefit to student and training system this represents. Reports detailing cost and resource implications for the ACMI system are obtainable from the system contractor, Cubic Corp. An anaylsis of costs for the ACMI system is not included in this report.

Attachment I

F-16 INSTRUCTIONAL SUBSYSTEMS AND FUNCTIONS LIST

This section names the subsystems of the F-16 instructional systems and the functions to be carried out by each. Figure I-1 shows the subsystems and their relations to each other. One subsystem placed beneath anoother on this chart is under the control and supervision of the higher system.

Subsystems were identified through an analysis of the functions required to operate the F-16 instructional system. System procedures must be planned around the execution of those functions. This allows the planning of system management and operation to be deliberate and systematic. In the future it will ensure that changes in system resources or requirements which dictate changes in system operation can be dealt with in the same straightforward way. Functions specified in this section may be prioritized, modified, combined, reassigned, eliminated, or otherwise manipulated directly through the use of the functional list.

The records and reports, and scheduling subsystems are not independent of the other subsystems. For the most part the functions carried out within these two subsystems are in support of the functions of the remaining subsystems. There is a close correspondence therefore, between functions of the records and reports, and scheduling subsystems and coordinate functions in the other subsystems. These correspondences are marked with a parenthetic note referring to the appropriate corresponding function.

The list of subsystems and their functions follows. An FL number is given to each function for identification purposes. Functions are shown in outline form. Detailed planning occurs for those functions which lie at the lowest levels of the outline.

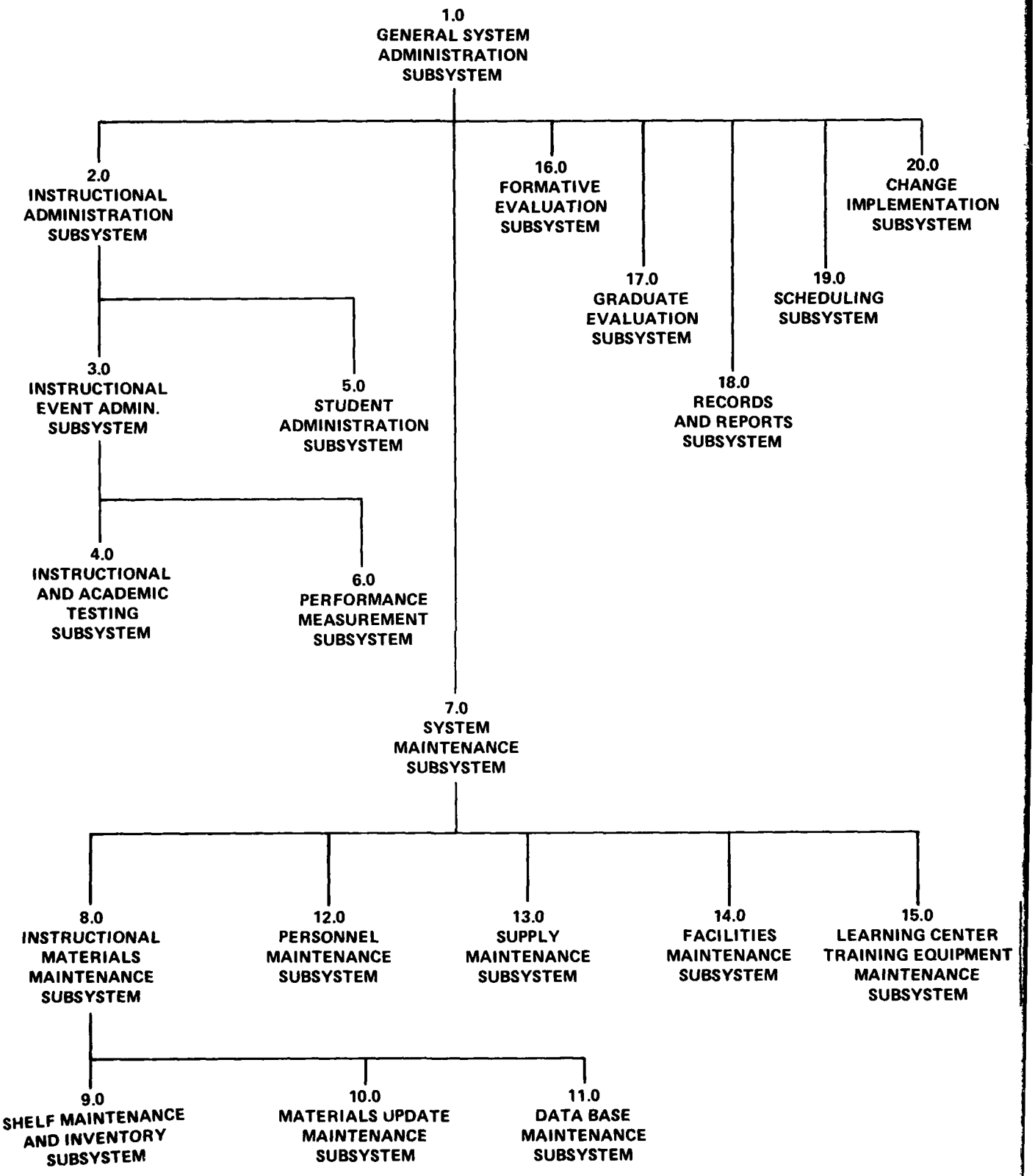

FIGURE I–1. SUBSYSTEMS WITHIN THE F-16 TRAINING SYSTEM.

Subsystem: General System Administration.

Functions:

FL 3.0 Perform general system administration

FL 3.1 Prepare instructional system budget, production forecast, and schedules report (see FL 8.1.1)

FL 3.2 Acquire system resources and personnel

FL 3.3 Summarize and report system activity and fitness (see FL 7.1.1)

FL 3.4 Analyze and report system resource expenditures (see FL 7.1.2)

FL 3.5 Supervise coordination of all system-related service agencies

FL 3.6 Review, approve and implement all proposed system modifications and initiate modifications planning as needed (see FL 8.1.2)

FL 3.7 Supervise and manage all resource and personnel use

FL 3.8 Supervise operation of all subsystems

Subsystem: Instructional Administration

Functions:

FL 2.1 Schedule and supervise instructional personnel (see FL 8.2.1)

FL 2.2 Coordinate materials and gradeslip update

FL 2.3 Schedule and supervise Learning Center personnel (see FL 8.2.2)

Subsystem: Instructional Event Administration

Functions:

FL 2.4 Conduct instructional event administration
- FL 2.4.1 Issue and retrieve instructional materials
  - FL 2.4.1.1 Issue and retrieve unclassified instructional materials for student use (see FL 7.2.1 and FL 7.2.2)
    - *FL 2.4.1.1.1 Issue and retrieve instructional materials for student use
    - *FL 2.4.1.1.2 Issue and retrieve academic tests (other than end-of-phase exams)
    - *FL 2.4.1.1.3 Issue and retrieve equipment for student use
  - *FL 2.4.1.2 Issue and retrieve instructional materials (equipment, materials) for instructor use in classroom (see FL 7.2.3 and FL 7.2.4)
  - *FL 2.4.1.3 Issue and retrieve classified instructional materials/tests for student or instructor use (see FL 7.2.1 and FL 7.2.2)
  - *FL 2.4.1.4 Issue and retrieve adjunct study materials (see FL 7.2.3 and FL 7.2.4)
- FL 2.4.2 Instruct student in use of instructional materials/tests

Subsystem: Instruction and Academic Testing

Functions:

FL 1.0 Conduct instruction and academic testing

FL 1.1 Conduct instruction
- *FL 1.1.1 Select instructional event (progressional or remedial) (see FL 8.3.1)
- *FL 1.1.2 Determine student qualification for the instructional event
- *FL 1.1.3 Schedule the instructional event, equipment, and personnel (see FL 8.3.1, FL 8.3.2, and FL 8.3.3)
- FL 1.1.4 Execute instructional event
  - FL 1.1.4.1 Execute mediated academic instructional presentations
  - FL 1.1.4.2 Execute discussion group
  - FL 1.1.4.3 Execute tutoring session
  - FL 1.1.4.4 Execute training device session
  - FL 1.1.4.5 Execute aircraft flight
- *FL 1.1.5 Produce record of event outcome (see FL 7.3.1)
- *FL 1.1.6 Determine need for remediation (see FL 7.3.2)

FL 1.2 Conduct testing
- FL 1.2.1 Determine need for informal academic test (see FL 8.3.1)
  - *FL 1.2.1.1 Determine need and form for informal academic test
  - *FL 1.2.1.2 Determine need and form for formal academic test
  - *FL 1.2.1.3 Determine need and form for academic certification test
- FL 1.2.2 Schedule academic test (see FL 8.3.1)
- FL 1.2.3 Administer test
- *FL 1.2.4 Score test/assign grade (see FL 7.3.3)
- *FL 1.2.5 Provide feedback on test results (see FL 7.3.4)
- *FL 1.2.6 Record scores/grades and other test data (see FL 7.3.5)

Subsystem: Performance Measurement

Functions:

FL 1.2.3.2 Administer performance test
- FL 1.2.3.2.1 Determine need and form for informal performance test (see FL 8.4.1)
- FL 1.2.3.2.2 Determine need for formal performance test (see FL 8.4.1)
- FL 1.2.3.2.3 Determine need for performance certification test (see FL 8.4.1)
- FL 1.2.3.2.4 Schedule performance test (see FL 8.4.1)
- FL 1.2.3.2.5 Administer performance test
- FL 1.2.3.2.6 Store test/assign grade
- FL 1.2.3.2.7 Provide feedback on test results (see FL 7.4.2)
- FL 1.2.3.2.8 Record scores/grades and other test data (see FL 7.4.3)

Subsystem: Student Administration

Functions:

FL 2.5 Conduct student administration
- FL 2.5.1 Screen incoming students
  - FL 2.5.1.1 Create student entry skill level record
    - *FL 2.5.1.1.1 Administer skill pretests and interviews as required
    - *FL 2.5.1.1.2 Collect previous records of skill levels (see FL 7.5.1)
    - *FL 2.5.1.1.3 Analyze incoming student data
  - FL 2.5.1.2 Compare student profiles with minimal entry requirements and decide to reject/remediate/accept the individual student (see FL 7.5.2)
  - FL 2.5.1.3 Match instructional plan to student incoming characteristics
    - *FL 2.5.1.3.1 Prescribe appropriate entry level to instruction
    - *FL 2.5.1.3.2 Prescribe remediation instruction (see FL 8.5.1)
    - *FL 2.5.1.3.3 Select student/instructor matchings if required (see FL 8.5.2)
    - *FL 2.5.1.3.4 Prescribe strategy options, pace options, media options, etc. available to student
- FL 2.5.2 Enroll student in system
  - FL 2.5.2.1 Set up record (see FL 7.5.3)
  - *FL 2.5.2.2 Provide orientation to base and training system policies and facilities
  - FL 2.5.2.3 Provide passes/badges/ID/other administrative paperwork (see FL 7.5.4)
  - FL 2.5.2.4 Produce training schedule for individual student (see FL 7.5.5)
- FL 2.5.3 Provide advisement
  - FL 2.5.3.1 Provide system initiated advisement
    - *FL 2.5.3.1.1 Provide periodic advisement
    - *FL 2.5.3.1.2 Provide student-specific, criterion-referenced advisement
      - FL 2.5.3.1.2.1 Determine to progress or remediate student
      - FL 2.5.3.1.2.2 Plan remedial program for student
    - *FL 2.5.3.2 Provide student-requested advisement
- FL 2.5.4 Provide tutoring
  - *FL 2.5.4.1 Provide system initiated tutoring
  - *FL 2.5.4.2 Provide student initiated tutoring
- *FL 2.5.5 Conduct elimination procedure
- FL 2.5.6 Graduate student
  - *FL 2.5.6.1 Summarize records (see FL 7.5.5)
  - *FL 2.5.6.2 Close files
  - *FL 2.5.6.3 Pass data to next school/agency/assignment (see FL 7.5.6)
  - *FL 2.5.6.4 Issue certification of graduation/elimination/washback to all appropriate agencies (see FL 7.5.6)

FL 2.5.6.5 Retrieve all materials/equipment from students

FL 2.5.6.6 Cancel schedules/assignments

Subsystem: Instructional Materials Maintenance

Functions:

FL 4.1 Schedule and supervise instructional development personnel (see FL 8.6.2, FL 8.6.3, FL 7.6.1, and FL 7.6.3)

FL 4.2 Coordinate schedules and volumes with development support service heads (e.g., photo, audio recording) (see FL 8.6.1 and FL 7.6.2)

Subsystem: Shelf Maintenance and Inventory

Functions:

FL 4.2 Perform instructional materials, tests, and equipment shelf maintenance
- FL 4.2.1 Store instructional materials, tests, and equipment
  - *FL 4.2.1.1 Store unclassified instructional materials, and equipment
  - *FL 4.2.1.2 Store classified instructional materials, and equipment
  - *FL 4.2.1.3 Store tests
- *FL 4.2.2 Assemble instructional materials, tests, and equipment for delivery to student/instructor (see FL 7.7.1)
- *FL 4.2.3 Distribute instructional materials
- *FL 4.2.4 Collect instructional materials
- *FL 4.2.5 Inspect instructional materials (see FL 7.7.2)
- *FL 4.2.6 Repair/replace or order instructional materials
- FL 4.2.7 Maintain material availability levels
  - *FL 4.2.7.1 Inventory number, condition, location of materials, copies (see FL 7.7.4)
  - *FL 4.2.7.2 Compare inventory with specified on-hand levels required
  - *FL 4.2.7.3 Order additional copies of materials

Subsystem: Materials Update Maintenance

Functions:

FL 4.3 Revise or author new instructional materials, tests, training guides, briefing guides, instructor guides, phase manuals, etc.
- FL 4.3.1 Conduct QC data review
- FL 4.3.2 Determine need for revision or need for new materials
- FL 4.3.3 Write revision specifications or specifications for new materials
- FL 4.3.4 Author, review, and approve draft materials
- FL 4.3.5 Produce tryout version
- FL 4.3.6 Conduct tryout
- FL 4.3.7 Conduct tryout data review
- FL 4.3.8 Determine need for revision
- FL 4.3.9 Write revision specifications
- FL 4.3.10 Author and produce revisions
- FL 4.3.11 Produce final versions

Subsystem: Data Base Maintenance

Functions:

FL 4.4 Revise system data base documents (see FL 7.8.1, FL 7.8.2, and FL 8.7.1)
- FL 4.4.1 Revise task listing data base document
- FL 4.4.2 Revise criterion-referenced objectives data base document
- FL 4.4.3 Revise objectives hierarchies data base document
- FL 4.4.4 Revise target population survey data base document
- FL 4.4.5 Revise goal analysis data base document
- FL 4.4.6 Revise media selection data base document
- FL 4.4.7 Revise syllabus data base document
- FL 4.4.8 Revise TSRA current calculation report data base document
- FL 4.4.9 Revise system design data base documents (instructional, management, performance measurement)
- FL 4.4.10 Revise quality control data base document

FL 4.5 Revise system ISD procedures documents
- FL 4.5.1 Revise task listing procedures document
- FL 4.5.2 Revise criterion-referenced objectives procedures document
- FL 4.5.3 Revise objectives hierarchies procedures document
- FL 4.5.4 Revise target population survey procedures document
- FL 4.5.5 Revise goal analysis procedures document
- FL 4.5.6 Revise media selection procedures document
- FL 4.5.7 Revise syllabus construction procedures document
- FL 4.5.8 Revise training support requirements analysis procedures document
- FL 4.5.9 Revise authoring and production procedures documents

FL 4.6 Revise system plan documents

Subsystem: Personnel Maintenance

Functions:

FL 4.7 Perform personnel acquisition, training, and certification
- FL 4.7.1 Select personnel for system
- *FL 4.7.2 Train system personnel (see FL 8.8.1)
- FL 4.7.3 Conduct personnel certification (see FL 7.9.1 and FL 8.8.2)
- *FL 4.7.4 Monitor, evaluate, and report on-the-job performance
- FL 4.7.5 Conduct inservice training

Subsystem: Supply Maintenance

Function:

FL 4.8 Perform supply maintenance
- FL 4.8.1 Maintain adequate supply levels for instructional development personnel
- FL 4.8.2 Maintain adequate supply levels for students
- FL 4.8.3 Maintain adequate supply levels for instructors
- LF 4.8.4 Maintain adequate supply levels for administrative support personnel

Subsystem: Facilities Maintenance

Functions:

FL 4.9 Perform facilities working order maintenance
- FL 4.9.1 Observe necessary security procedures
- FL 4.9.2 Maintain life support systems (e.g., electricity, air conditioning, water, rest rooms)
- FL 4.9.3 Ensure safety conditions
- FL 4.9.4 Perform custodial functions

Subsystem: Learning Center Training Equipment Maintenance

Function:

FL 4.10 Perform Learning Center training equipment working order maintenance (see FL 7.7)
- FL 4.10.1 Store equipment
  - *FL 4.10.1.1 Store unclassified equipment
  - *FL 4.10.1.2 Store classified equipment
  - *FL 4.10.1.3 Store equipment replacement parts and tools
- FL 4.10.2 Provide equipment for use by instructor/student
  - *FL 4.10.2.1 Provide equipment for use within classroom/carrels
  - *FL 4.10.2.2 Provide equipment for use outside classroom/carrels
- *FL 4.10.3 Inspect equipment
- *FL 4.10.4 Troubleshoot and repair/replace malfunctioning equipment
- FL 4.10.5 Maintain equipment availability levels
  - *FL 4.10.5.1 Inventory number, condition, location of equipment
  - *FL 4.10.5.2 Compare inventory with specified onhand levels required
  - *FL 4.10.5.3 Order additional pieces of equipment

Subsystem: Formative Evaluation

Function:

FL 5.0 Perform ongoing system formative evaluation

FL 5.1 Plan formative evaluation activities and schedules (see FL 8.9.1)

FL 5.2 Coordinate data collection needs and schedules with system management

FL 5.3 Design/revise data analysis procedures

FL 5.4 Produce/revise instruments for data collection

FL 5.5 Collect evaluation data (see FL 7.10.1)

FL 5.6 Analyze evaluation data

FL 5.7 Produce evaluation summary reports (see FL 7.10.2)

Subsystem: Graduate Evaluation

Function:

FL 6.0 Perform graduate evaluation

FL 6.1 Plan graduate evaluation activities (see FL 8.10.1)

FL 6.2 Coordinate graduate evaluation needs and schedules with system management and operational commanders

FL 6.3 Design/revise, prepare, and send evaluation materials

FL 6.4 Conduct evaluation interviews (see FL 7.11.1)

FL 6.5 Analyze evaluation data

FL 6.6 Prepare evaluation summary report (see FL 7.11.2)

Subsystem: Records and Reports

Functions:

FL 7.0 Produce system records and reports

FL 7.1 Produce general system administration records and reports
- FL 7.1.1 Produce systems activity report
- FL 7.1.2 Produce system resource utilization report

FL 7.2 Produce instructional event adminstration reports
- FL 7.2.1 Collect data on instructional material, test, and learning center equipment issue and retrieval (classified and unclassified)
- FL 7.2.2 Produce instructional materials, tests, and learning center equipment usage report (classified and unclassified)
- FL 7.2.3 Collect data on issue and retrieval of instructional materials to instructors, and issue and retrieval of adjunct study materials
- FL 7.2.4 Produce report on instructor usage of instructional materials and use of adjunct study materials

FL 7.3 Produce instruction and academic testing reports and records
- FL 7.3.1 Collect data on instructional event outcomes
- FL 7.3.2 Produce remediation needs report
- FL 7.3.3 Score tests/assign grades
- FL 7.3.4 Produce test results report
- FL 7.3.5 Record test results in student record
- FL 7.3.6 Produce instruction and student summary performance reports

FL 7.4 Produce performance measurement records and reports
- FL 7.4.1 Collect data from performance measurement test
- FL 7.4.2 Produce student performance measurement test results report
- FL 7.4.3 Record performance measurement test results in student record
- FL 7.4.4 Produce test and student summary performance reports

FL 7.5 Produce student administration records and reports
- FL 7.5.1 Include incoming student records in student training record
- FL 7.5.2 Produce student profile comparison report
- FL 7.5.3 Set up new student record
- FL 7.5.4 Prepare incoming student administrative paperwork
- FL 7.5.5 Produce student terminal training
- FL 7.5.6 Produce reports for forwarding to student's receiving command and all appropriate agencies

FL 7.6 Produce instructional materials maintenance reports and records
- FL 7.6.1 Produce instructional development progress and shortfall reports
- FL 7.6.2 Produce instructional development resource and resource utilization reports
- FL 7.6.3 Produce instructional development personnel and resource utilization reports

FL 7.7 Produce shelf maintenance and inventory records and reports
- FL 7.7.1 Produce segment materials list report
- FL 7.7.2 Collect data on damaged or missing instructional materials
- FL 7.7.3 Produce materials replacement report
- FL 7.7.4 Produce current materials expected inventory report

FL 7.8 Produce data base maintenance reports and records
- FL 7.8.1 Produce current version printout of all data base documents
- FL 7.8.2 Collect data on all data base document changes and enter into record

FL 7.9 Produce personnel maintenance records and reports
- FL 7.9.1 Produce personnel certification status reports

FL 7.10 Produce formative evaluation records and reports
- FL 7.10.1 Collect data from formative evaluation procedures
- FL 7.10.2 Produce formative evaluation summary reports

FL 7.11 Produce graduate evaluation records and reports
- FL 7.11.1 Collect dates from graduate evaluation procedures
- FL 7.11.2 Produce graduate evaluation summary report

FL 7.12 Disseminate reports to appropriate agencies

FL 7.13 Dispense records to appropriate receiving commands

Subsystem: Scheduling

Functions:

FL 8.0 Perform system scheduling

FL 8.1 Perform general system administrative scheduling
- FL 8.1.1 Produce system combined resource and personnel use forecasts and schedules for long-range planning

FL 8.2 Perform instructional administration scheduling
- FL 8.2.1 Produce instructional development personnel and service agency utilization schedules
- FL 8.2.2 Produce Learning Center personnel utilization schedules (daily schedule type)

FL 8.3 Perform instructional and academic testing scheduling
- FL 8.3.1 Produce instructional event and test presecriptions and schedules for individual students
- FL 8.3.2 Produce equipment use schedule for each piece of equipment
- FL 8.3.3 Produce instructor personnel schedules

FL 8.4 Perform performance measurement scheduling
- FL 8.4.1 Produce performance measurement test ready list and schedule
- FL 8.4.2 Produce schedule for equipment to be used in testing

FL 8.5 Perform student administration scheduling
- FL 8.5.1 Produce entering student remediation prescription and schedule
- FL 8.5.2 Collect data on student/instructor pairing, if any
- FL 8.5.3 Produce initial student training schedule

FL 8.6 Perform instructional materials maintenance scheduling
- FL 8.6.1 Produce instructional development product schedules (PERT type)
- FL 8.6.2 Produce instructional materials periodic inspection and review schedule
- FL 8.6.3 Produce instructional development personnel daily work schedules

FL 8.7 Perform data base maintenance scheduling
- FL 8.7.1 Produce data base document regular review schedule

FL 8.8 Perform personnel maintenance scheduling
- FL 8.8.1 Produce personnel training schedules
- FL 8.8.2 Produce personnel recertification schedules

FL 8.9 Perform formative evaluation scheduling
- FL 8.9.1 Produce formative evaluation segment review schedule

FL 8.10 Perform graduate evaluation scheduling
- FL 8.10.1 Produce graduate evaluation activities schedule

FL 8.11 Perform change implementation scheduling
FL 8.11.1 Produce change implementation schedules

Subsystem: Change Implementation

Function:

FL 9.0 Implement system change

FL 9.1 Schedule implementation activities (see FL 8.11.1)

FL 9.2 Arrange for cooperative agency coordination

FL 9.3 Procure/order equipment and facilities

FL 9.4 Receive and inspect equipment and facilities

FL 9.5 Set up and test equipment

FL 9.6 Select and train system personnel

FL 9.7 Rehearse or simulate system functioning

Attachment II

COST DETAILS FOR OPTION II-IV
REPORTED COST INCREASE FIGURES

I. The following details are provided for the overall costs reported for Option II.

A. Added Costs

1. Equipment Costs

Equipment and Costs		Remarks
1--Central processing unit (CPU)	$ 30,000	Assume upward expandable minicomputer with 256k core memory. Extreme caution is advised in not undersizing this unit.
2--Disc memory units (80-100M)	$ 50,000	Adequate redundancy is provided to eliminate the need for tape memory.
2--Fast printers	$ 12,000	Designated to provide high-volume print capability.
7--CRT terminals	$ 17,500	Provides sufficinet terminals for redundancy to provide back-ups in case of breakdowns or student surges.
1--Slow printer	$ 3,000	For Learning Center utility functions.
Communications hardware	$ 20,000	
2--Mark-sense readers	$ 30,000	
Solftware licenses	$ 5,000	
Miscellaneous cabling	$ 2,000	
TOTAL	$169,500	

2. Installation costs (assuming availability of suitable 600 square foot facitiliy available without modification required to accept system).

Costs	Remarks
Wiring and air conditioning $10,000	
Installation personnel $ 5,000	
Flooring $ 6,000	
Transportation and insurance $ 5,000	
TOTAL $26,000	

3. Recurring materials and supplies costs, including memory discs, and printer paper.

Costs	Remarks
Materials and supplies $4,000	
TOTAL $4,000	

4. Recurring maintenance costs, assuming vendor-supplied maintenance services.

Costs	Remarks
Yearly maintenance contract $17,000	
TOTAL $17,000	

5. Recurring personnel costs.

Personnel and Costs		Remarks
2--Operators	$32,000	Assumes two-shift per day operation, one operator per shift.
1--Software programmer/analyst	$22,000	
TOTAL	$54,000	

6. One-time programming (software) costs.

Costs		Remarks
1-1/2 Man-years--advanced system analyst	$42,000	
1 Man-year--programmer I	$22,000	
2 Man-years--programmer II	$32,000	
TOTAL	$96,000	

B. Reduced Costs

Item*	Number	Rate	Costs
Administrative personnel salary	4	$6,768	$27,072
Office space maintenance	280 ft	$40	11,200
Office furnishings	4	$500	2,000
TOTAL			$40,272

*All lost costs are operating costs except office furnishings.

II. The following details are provided for the overall costs reported for Option III:

A. Added costs--USAF-built CAI system.

1. Equipment Costs

Equipment and Costs		Remarks
1--Central processing unit (CPU)	$ 30,000	Assumes an upward expendable mini-computer with 256k memory.
1--Disc memory unit (80-100M)	$ 25,000	
1--Adminstrative terminal	$ 2,500	
1--Fast printer	$ 6,000	
Communications hardware	$ 20,000	
1--Graphics digitizer (on site only)	$ 40,000	
20--Terminals at $7,500	$150,000	More expensive terminals due to lack of software graphic programs
Software licenses	$ 5,000	
Miscellaneous cabling	$ 2,000	
TOTAL	$280,000	

2. Interface costs for connecting CAI and CMI system through communications link.

Costs		Remarks
Programming	$ -0-	No cost required due to absorption of interface in programming costs with system programming costs.
Hardware (per system)	$10,000	
TOTAL	$10,000	

3. Installation costs (assuming availability of suitable 600 square foot facility available).

Costs		Remarks
Wiring	$ 4,300	
Installation personnel	$ 5,000	
Transportation and insurance	$ 5,000	
TOTAL	$15,000	

4. Recurring materials and supplies costs, including memory discs, and printer paper.

Costs		Remarks
Materials and supplies	$4,000	
TOTAL	$4,000	

5. Recurring maintenance costs, assuming vendor-supplied maintenance services.

Costs	Remarks
Yearly maintenance contract $28,000	
TOTAL $28,000	

6. Recurring personnel costs

Personnel and Costs	Remarks
2 Operators $32,000	
1 Programmer/analyst $22,000	
TOTAL $54,000	

7. One-time programming (software) costs, including authoring system, recording and reporting data base maintenance, and CAI/CMI interface programs.

Costs	Remarks
24-3/4 Man-years advanced system analyst $ 293,000	
16-1/2 Man-years--Programmer I $ 363,000	
33-3/4 Man-years--Programmer II $ 540,000	
TOTAL $1,596,000	

C. Added costs--ready-made CAI system

1. Equipment costs

Equipment and Costs		Remarks
1--Basic CAI system, including operating software	$150,000	Assumes a four-terminal system.
1--Graphics digitizes (one-time cost)	$ 40,000	
16--Additional terminals at $2,500	$ 40,000	Making it a total 20-terminal system.
TOTAL	$230,000	

2. Equipment interface costs for connecting CAI and CMI systems through communications link.

Costs		Remarks
Equipment (per system)	$10,000	
TOTAL	$10,000	

3. Installation costs (assuming availability of suitable 600 square foot facility available).

Costs		Remarks
Wiring	$ 4,000	
Installation personnel	$ 5,000	
Transportation and insurance	$ 5,000	
TOTAL	$14,000	

4. Recurring materials and supplies costs, including memory discs, and printer paper.

Costs	Remarks
Materials and supplies $4,000	
TOTAL $4,000	

5. Recurring maintenance costs, assuming vendor-supplied maintenance services.

Costs	Remarks
Yearly maintenance contract $28,000	
TOTAL $28,000	

6. Recurring personnel costs

Costs	Remarks
2--Operators $32,000	
1--Programmer/analyst $22,000	
TOTAL $54,000	

7. One-time programming (software) costs, including interface of CAI and CMI systems.

Costs	Remarks
1.2--Man-years--advanced systems analyst $ 33,000	
1--Man-years--Programmer I $ 22,000	
2.8--Man-years--Programmer II $ 45,000	
TOTAL $100,000	

C. Added costs--part-task trainer component

1. Equipment costs

Equipment and Costs		Remarks
4--CFT's wired for connection	$100,000	$40,000 first copy, $20,000 for subsequent copies.
TOTAL	$100,000	This total cost falls to $10,000 for 2D trainers

2. Installation costs to hook PTTs into CAI system.

Costs		Remarks
Manpower and equipment	$10,000	
TOTAL	$10,000	

3. One-time programming costs.

Costs		Remarks
Basic system programming	$ 90,000	This cost falls to $40,000 for a 2D system.
Exercise programming	$ 10,000	Assuming 12-15 minute PTT exercises to be programmed.
TOTAL	$100,000	

D. Added costs--instructional development

1. One-time instructional development costs for tactical and part-task trainer instruction.

Costs		Remarks
Materials development	$ 95,130	
Exercise development	$ 8,740	
TOTAL	$103,870	

B. Reduced Costs

Item*	Number	Rate	Costs
Reduction in aircraft time		3%	$ 857,664
Instructor salary	6	$21,960	131,760
Office space maintenance	6	$40	16,800
Office furnishings	6	$500	3,000
TOTAL			$1,009,224

*All lost costs are operating costs except office furnishings.

III. The following details are provided for the overall costs reported for Option IV:

A. Added costs

Equipment and Costs	Remarks
1--Disc memory unit (30-100M) $ 25,000	
1--Central processing unit (CPU) $ 30,000	
20--Student terminal at $2,500 $ 50,000	For a total of 40 terminals.
1--Part task trainer interface equipment $ 10,000	
TOTAL $115,000	

2. Installations costs (assuming suitable facility already existing for CAI/CMI system).

Costs	Remarks
Wiring $ 4,000	
Installation personnel $ 5,000	
Transportation & insurance $ 5,000	
TOTAL $14,000	

3. Recurring materials and supplies costs

Costs	Remarks
Materials and supplies $4,000	
TOTAL $4,000	

4. Recurring maintenance costs, assuming vendor-supplied maintenance services.

Costs	Remarks
Yearly maintenance contract $17,000	
TOTAL $17,000	

5. Recurring personnel costs

Personnel and Costs	Remarks
Personnel $ -0-	
TOTAL $ -0-	

6. One-time programming (software) costs (CMI)

Costs		Remarks
1-1/2 Man-years--advanced system analyst	$42,000	
1 Man-year--Programmer I	$22,000	
2 Man-years--Programmer II	$32,000	
TOTAL	$96,000	

7. One-time programming (software) costs--(PTT)

Costs		Remarks
1.2 Man-years--advanced systems analyst	$ 33,000	Assumes integration of three
1 Man-year--Programmer I	$ 22,000	
2.8 Man-years--Programmer II	$ 45,000	
TOTAL	$100,000	

8. One-time instructional development costs for CAI and part-task training upgrade.

Costs		Remarks
Instructional materials	$188,674	Assumes computerization of 119 hours of existing instruction (at three segments per hour).
CAI simulation exercises	$ 46,084	Assumes programming of 10 simulation exercises.
Part-task trainer integrated exercises	$ 6,555	Assumes programming of three hours of integrated exercises (nine sessions at 15 minutes per session).
TOTAL	$241,313	

B. Reduced costs

Item*	Number	Rate	Costs
Administrative personnel salaries	3	$6,768	$ 20,304
Office space	3	$40	8,400
Offic furnishings	3	$500	1,500
Instructor salaries	3	$21,960	65,880
Office space	3	$40	8,400
Office furnishings	3	$500	1,500
Reduction in aircraft time		2%	554,622
TOTAL			$660,606

*All lost costs are operating expenses except office furnishings.


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